closed pupil or channel **303**. The pupil may be considered as being formed in a ridge structure upstanding from the surface of the substrate, the ridge structure forming a diaphragm electrode.

[0030] Additional patterning and directional etching processes such as deep reactive ion etching may be used to define a set of separate electrode features **401** separated by small gaps **402** and containing grooves **403**, lying on a common substrate **404** as shown in FIG. **4**. The substrate may be partially removed to leave two distinct sections **405***a* and **405***b* separated by a gap **406**. It will be appreciated that the underlying substrate can provide electrical isolation between the electrodes if formed in a suitable insulating material, for example, a glass, a plastic or ceramic. It will also be appreciated that the gap **406** may serve to minimize charging effects in an application involving an ion beam.

[0031] If the second patterning and etching steps are carried out after formation of the initial groove, the second lithography must be carried out on a surface that is substantially non-planar. The necessary photoresist layer may be formed using an electrically deposited photoresist (Kersten 1995). Such a process has been described and used to construct an electrode system in an alternative ion optical application involving electrospray (Syms 2007; GB 0514843.2).

[0032] It will be appreciated that the combination of two such substrates as will create a structure containing a set of diaphragms containing closed pupils, and hence will form the main features of a stacked ring ion guide shown previously in FIG. **1**. The use of the word "stack" in this context will be understood as a plurality of electrodes each provided with a closed pupil arranged along an ion path axis. The axis is longitudinal such that the stack may be considered as being a stack arranged in an orientation substantially transverse to the upper surfaces of the substrates. Each of the formed electrodes form one of the rings of the stacked ring ion guide.

[0033] It will also be appreciated that the cross-sections in FIG. **2** will give rise to different approximations to the most desirable electrode pupil shape, namely a circle. It will further be appreciated that this mode of construction differs from that of GB 2,397,690, in which the structure is fabricated in two halves, each half containing complete ring electrodes rather than partial rings as shown here. It will be understood that by following the teaching heretofore it is possible to ensure that the ion axis through the ring arrangement is substantially coincident with the central axis of the pupil. As the pupil is fabricated from two equal half portions, this means that the ion axis is substantially located along the plane defined by the mating surfaces of the two features **202**. By etching one feature more dominantly than the other such that the final aperture is predominately located in one half of the sandwich structure, it will be understood that a shift in the ion axis towards that side of the structure will be effected. If, in the ultimate etching arrangement that a groove is only fabricated in one half of the sandwich structure and that the second half simply seals the aperture, then the ion axis will be wholly defined within the feature that defines the groove.

[0034] Assembly of the complete structure may be carried out by a variety of methods, including but not restricted to gluing, soldering, and bonding. Some of these methods (for example, soldering) require the deposition of an additional metal layer on the exposed upper surface of each etched layer. Suitable metals include (but are not restricted to) copper and gold, and suitable methods of deposition include RF sputtering. Such a layer can also serve to improve electrical conductivity, and provide a means for electrical contact to the electrodes, and for attaching bond wires. The metal layer may coat the sidewalls of the electrodes. In this case, a method must be provided to ensure that a short circuit between electrodes is not created via the substrate. One suitable method is to form the electrodes on a first wafer, which is subsequently attached to the second insulating substrate wafer.

[0035] Similar secondary patterning and etching processes may be used to define a structure **501***a* consisting of a substrate **502** carrying two sets of electrodes **503***a* and **503***b* linked together with bus bars **504***a* and **504***b* as shown in FIG. **5**. The electrodes **503***a* and **503***b* may carry a common etched groove **505** and the bus bars **504***a* and **504***b* may carry etched recesses **506***a* and **506***b*. A similar, but slightly smaller structure **501***b* may be constructed in a similar way, carrying a mirror image of the electrode layout but omitting the recessed sections of the bus bars.

[0036] It will be appreciated that the structures **501***a* and **501***b* may be combined together to form an assembly **507**. If the upper surface of each electrode structure is metallized, it will be appreciated that bond wires **508***a* and **508***b* may be attached to the exposed recesses **506***a* and **506***b* to provide electrical connections. The electrical connections may be used to apply voltages to the electrodes following the scheme shown in FIG. **1**.

[0037] It will further be appreciated that there are considerable possibilities for realizing different arrangements of ion guide, depending on the initial lithographic pattern and the process used for forming the groove. FIG. **6** shows two examples. The axis of ion propagation may be meandered, by slowly varying the lithographic pattern used to define the position of the groove **601**. Larger variations of the direction of the ion path may also be created, by additionally varying the lithographic pattern used to define the position and orientation of the separate electrodes **602**. For example, a circular ion path may be provided, by bending the groove into a complete circle, and arranging the electrodes as radial spokes. In this case, an ion storage ring may be constructed.

[0038] The effective width of the ion guide may also be varied, by slowly varying the lithographic pattern used to define the width of the groove **603**. The groove may also be varied in depth using suitable etching process, such as multi-step etching with a movable mask that serves to protect different parts of the structure for parts of the process, so that they are etched for different times. In this case, an ion funnel may be constructed.

[0039] The fabrication methods described above may be applied to a complete wafer, which will conventionally be large enough to contain a number of similar components. The wafer may therefore provide sufficient components for a batch of separate ion guides. However, it will be appreciated that several such ion guides may be arranged in parallel on larger dies, to provide components capable of guiding several ion streams in parallel.

[0040] The fabrication methods above are in some cases compatible with the formation of an additional ion optical component, for example a quadrupole mass filter as described in GB 0701809.6, the content of which is incorporated herein by reference. This application describes a quadrupole acting in conjunction with a prefilter and is formed using a compatible two substrate assembly. In this way it will be understood that the fabrication of the mass filter may be made concurrently with the ion optics such that the ions within the ion guide provided by the present invention may be directly inter-